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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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# Development of USES Aptitude Test Battery for Electronics Assembler

(electronics) 726.781

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U.S. DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary
MANPOWER ADMINISTRATION
BUREAU OF EMPLOYMENT SECURITY
Washington, D.C. 20210

Technical Report on Development of USES Aptitude Test Battery

For .....

Electronics Assembler (electronics) 726.781

S-310

U. S. Employment Service
in Cooperation with
Colorado and Utah State Employment Services

March 1967

## FOREWORD

The United States Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Frank H. Cassell

Frank H. Cassell, Director
U. S. Employment Service

GATB Study #2516
and #2633

# DEVELOPMENT OF USES APTITUDE TEST BATTERY

For

Electronics Assembler (electronics) 726.781
S-310R

This report describes research undertaken for the purpose of determining General Aptitude Test Battery (GATB) norms for the occupation of Electronics Assembler (electronics) 726.781. The following norms were established:

| GATB Aptitudes | Minimum Acceptable GATB, B-1002 Scores |
|---|---|
| G - General Learning Ability | 85 |
| S - Spatial Aptitude | 80 |
| P - Form Perception | 85 |
| M - Manual Dexterity | 95 |

## RESEARCH SUMMARY

Sample:
147 female applicants for employment as Electronics Assemblers at Litton Industries, Salt Lake City, Utah.

Criterion:
Supervisory ratings

Design:
Longitudinal (tests were administered prior to employment and criterion data were collected after the training period).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Predictive Validity:
Phi Coefficient = .45 ($P/2 < .0005$)

Effectiveness of Norms:

Only 68% of the non-test-selected applicants used for this study were good workers; if the applicants had been test-selected with the S-310 norms 85% would have been good workers. 32% of the non-test-selected applicants used for this study were poor workers; if the applicants had been test-selected with the S-310 norms, 15% would have been poor workers.

TABLE 1

Effectiveness of Norms

| | Without Tests | With Tests |
|---|---|---|
| Good Workers | 68% | 85% |
| Poor Workers | 32% | 15% |

SAMPLE DESCRIPTION

Size:

N = 147

Occupational Status:

Applicants

Work Setting:

Applicants were ultimately employed at Litton Industries in Salt Lake City, Utah.

Employer Selection Requirements:

Age: Company prefers applicants within an age range of 20-45 years.

Education: Tenth grade education is preferred.

Previous Experience: None

Tests: None

Other: Good visual acuity and normal color discrimination; personal interview.

Principal Activities:

The job duties for each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience:

All employees had at least two months of on-the-job training at the time criterion data were obtained.

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age and Education

| | Mean | SD | Range | r |
|---|---|---|---|---|
| Age (years) | 31.3 | 7.8 | 19-51 | -.135 |
| Education (years) | 11.7 | .9 | 9-15 | -.122 |

## EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002 A or B were administered during the period May 1963 through November 1963.

## CRITERION

The criterion data consisted of pooled ratings made by the first and second line supervisors on an adaptation of USES Form Sp-21, "Descriptive Rating Scale." Workers were rated after they had been on the job for a period of two months; pooled reratings were made two weeks later.

Rating Scale: An adaptation of the form SP-21 "Descriptive Rating Scale" was used. The scale (see Appendix) consists of five items covering different aspects of job performance, with four alternatives for each item. The alternatives indicate the different degrees of job proficiency.

Reliability: The correlation coefficient between the two sets of ratings is .86 indicating satisfactory reliability. The final criterion score consisted of the combined scores of the two sets of ratings.

Criterion Score Distribution:

| | |
|---|---|
| Possible Range: | 10-40 |
| Actual Range: | 10-40 |
| Mean: | 28.3 |
| Standard Deviation: | 6.5 |

Criterion Dichotomy: The criterion distribution was dichotomized into high and low groups by placing 32% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low criterion group as "poor workers." The criterion critical score was 27.

## APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitude K which does not have a high correlation with the criterion was considered for inclusion in the norms because the qualitative analysis indicated that it was important for the job duties and the sample had a relatively high mean score on this aptitude. A relatively high mean score with employed workers indicates that some sample pre-selection may have taken place. Tables 3, 4 and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

| Aptitude | Rationale |
|---|---|
| P - Form Perception | Required to follow assembly and wiring diagrams; identify components by size and shape; assemble components properly; visually follow wires from one terminal to another; and to make visual inspection of components and wires for defects and proper assembly. |
| K - Motor Coordination | Required to install components and wiring; thread component leads through circuit board eyelets; and make bends in wire leads. |
| F - Finger Dexterity | Required to use fingers to make any required bends in leads. |

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

| Aptitudes | Mean | SD | Range | r |
|---|---|---|---|---|
| G - General Learning Ability | 95.1 | 14.9 | 60-130 | .225** |
| V - Verbal Aptitude | 99.6 | 13.6 | 63-135 | .131 |
| N - Numerical Aptitude | 89.3 | 16.0 | 58-127 | .189* |
| S - Spatial Aptitude | 100.4 | 16.6 | 68-153 | .217** |
| P - Form Perception | 103.5 | 17.8 | 66-151 | .199* |
| Q - Clerical Perception | 105.4 | 16.1 | 75-163 | .130 |
| K - Motor Coordination | 111.2 | 15.9 | 74-153 | .118 |
| F - Finger Dexterity | 107.9 | 18.4 | 63-149 | .278** |
| M - Manual Dexterity | 113.1 | 19.8 | 70-168 | .286** |

*Significant at the .05 level.
**Significant at the .01 level.

TABLE 5

Summary of Qualitative and Quantitative Data

| Type of Evidence | Aptitudes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | G | V | N | S | P | Q | K | F | M |
| Job Analysis Data | | | | | | | | | |
| Important | | | | | X | | X | X | X |
| Irrelevant | | | | | | | | | |
| Relatively High Mean | | | | | | | X | X | X |
| Relatively Low Standard Dev. | X | X | | | | | | | |
| Significant Correlation with Criterion | X | | X | X | X | | | X | X |
| Aptitudes to be Considered for Trial Norms | G | | N | S | P | | K | F | M |

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of G, N, S, P, K, F and M at trial cutting scores were able to differentiate between the 68% of the sample considered good workers and the 32% of the sample considered poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly higher than one standard deviation below the mean will eliminate about one-third of the sample;

for four aptitude trial norms, cutting scores slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of G-85, S-80, P-85 and M-95 provided the highest degree of differentiation for the occupation of Electronics Assembler 726.781. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .45 (statistically significant at the .0005 level).

TABLE 6

Predictive Validity of Test Norms G-85, S-80, P-85 and M-95

| | Nonqualifying Test Scores | Qualifving Test Scores | Total |
|---|---|---|---|
| Good Workers | 25 | 75 | 100 |
| Poor Workers | 34 | 13 | 47 |
| Total | 59 | 88 | 147 |

Phi Coefficient ($\phi$) = .45 Chi Square ($X^2$) = 29.69
Significance Level = P/2 less than .0005

## DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-16 which is shown in Section II of the Manual for the General Aptitude Test Battery. A Phi Coefficient of .17 is obtained with the OAP-16 norms of G-90, S-85 and P-85.

S-310

GATB Study #2633

Electronics Assembler (electronics 726.781

Check Study #1 Research Summary

Sample:

57 female Electronics Assemblers employed at Hewlett-Packard Plant in Loveland, Colorado.

TABLE 7

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Aptitudes of the GATB

| | Mean | SD | Range | r |
|---|---|---|---|---|
| Age (years) | 28.3 | 10.0 | 18-57 | -.007 |
| Education (years) | 11.3 | 1.6 | 7-16 | -.032 |
| G - General Learning Ability | 101.2 | 15.6 | 72-139 | .107 |
| V - Verbal Aptitude | 100.7 | 12.9 | 68-145 | .091 |
| N - Numerical Aptitude | 97.7 | 19.0 | 53-133 | -.003 |
| S - Spatial Aptitude | 107.1 | 19.6 | 58-156 | .169 |
| P - Form Preception | 111.9 | 23.2 | 40-169 | .304* |
| Q - Clerical Perception | 109.3 | 14.7 | 69-143 | .146 |
| K - Motor Coordination | 108.6 | 16.9 | 60-159 | .302* |
| F - Finger Dexterity | 105.9 | 18.6 | 55-141 | .135 |
| M - Manual Dexterity | 108.6 | 20.2 | 52-149 | .250 |

*Significant at the .05 level.

Criterion:

Supervisory ratings

Design:

Concurrent (test and criterion data were collected at approximately the same time).

Principal Activities:

The job duties are shown in the Appendix and are comparable to the duties of the validation sample.

Concurrent Validity:

Phi Coefficient (Ø) = .25 (P/2 less than .05)

Effectiveness of Norms:

Only 72% of the non-test-selected workers in this sample were good workers; if the workers had been test-selected with the S-310 norms, 81% would have been good workers. 28% of the non-test-selected workers in this sample were poor workers; if the workers had been test-selected with the S-310 norms, only 19% would have been poor workers. The effectiveness of the norms when applied to this independent sample is shown graphically in Table 8:

TABLE 8

Effectiveness of S-310 Norms on Check Study Sample #1

| | Without Tests | With Tests |
|---|---|---|
| Good Workers | 72% | 81% |
| Poor Workers | 28% | 19% |

TABLE 9

Concurrent Validity of Test Norms of G-85, S-80, P-85 and M-95

| | Nonqualifying Test Scores | Qualifying Test Scores | Total |
|---|---|---|---|
| Good Workers | 12 | 29 | 41 |
| Poor Workers | 9 | 7 | 16 |
| Total | 21 | 36 | 57 |

Phi Coefficient (Ø) = .25

Significance Level = P/2 less than .05

Chi Square ($X^2$) = 3.59

A-P-P-E-N-D-I-X

LITTON INDUSTRIES

Rating Scales

for

_____
Occupation

☐ Trainee

☐ Employee

☐ First Rating

☐ Second Rating

Rated by _____

Rater's Position _____

Date of Rating _____
month day year

(For Research Purposes Only)

LITTON INDUSTRIES - RATING SCALE

(For Research Purposes Only)

Person to be Rated

1. Quantity of work: How much does this person get done?

☐ A. Does much more than expected.

☐ B. Does a little more than expected.

☐ C. Does a little less than expected.

☐ D. Does less than expected.

2. Quality of work: What is this person's ability to do high-grade work which meets quality standards?

☐ A. Work rarely needs checking.

☐ B. Work needs somewhat less than normal checking.

☐ C. Work needs somewhat more than normal checking.

☐ D. Work needs more checking than is desirable.

3. Speed of learning: How quickly does this person learn new job duties (tasks, work methods, and operating procedures)?

☐ A. Learns new job duties much faster than most workers.

☐ B. Learns new job duties a little faster than most workers.

☐ C. Learns new job duties a little more slowly than most workers.

☐ D. Learns new job duties more slowly than most workers.

4. Aptitude for job: How skillful is this person? Does she show a "knack" for this type of work?

☐ A. Much more proficient than most workers.

☐ B. A little more proficient than most workers.

☐ C. A little less proficient than most workers.

☐ D. Less proficient than most workers.

5. "All around" ability: Considering only the four factors already rated, what is this person's "all around" ability to do her job?

☐ A. An unusually competent worker--performance generally superior.

☐ B. A valuable worker--performance generally very good.

☐ C. A fairly proficient worker--performance generally acceptable.

☐ D. A less capable worker--performance rather limited.

ELECTRONIC ASSEMBLER 726.781

Job Summary: Assembles cables and component parts on decks and panels and assembles completed parts by combining deck and panels. Thoroughly checks all work for accuracy.

Job Duties: Ascertains from work order, the number of cables of a specific type needed. Selects wires of specified colors, markings, and lengths as indicated in the instructions; positions wire on board upon which a schematic diagram is laid out and nails protrude to locate wires. Follows diagram and loops ends of wire around nails. Laces wires together at specified points by looping plastic lacing around wires and knotting. Removes completed cable from board and places in order box. Determines from specification the type and number of decks (main chassis) of electronics equipment such as digital computers, oscilloscopes, and amplifiers. Selects proper printed circuit board from stock and places in clamp mounted on "Lazy-Susan" assembly table. Selects component parts from supply wheel beneath assembly table. Inserts pre-cut and pre-shaped lead wires of components such as diodes, transistors, capacitors, transformers, and resistors into mounting holes on printed circuit board, using fingers, tweezers, and small pliers, and following model or assembly drawing. May place one group or type of components in all the boards before placing a different group or type of components. Trims excess length of lead wires using small wire snips. Removes boards from clamps, places them on edge in slotted box. Takes box and places on work bench next to soldering bath. One by one, removes boards from slotted box and places them in a spring tension hand clamp. Holds clamp so that bottom surface of board is parallel with surface of solder bath and places board against solder for a sufficient length of time for the lead wires to become soldered to the printed circuit. Lifts board from solder bath, removes clamp, checks board for any unsoldered connections, and places board back in slotted box. Hand solders any loose connections. Learns from work order the type and number of front panels to be assembled. Obtains necessary quantity of panels from stock and places several panels in holding clamp attached to work bench. Selects various components such as meters, switches, light indicators, panel jacks, selection knobs, etc., from supply boxes on bench and fastens them to proper places on panel using such hand tools as set wrenches, end wrenches, and screw drivers. Inserts ends of pre-cut wires into terminals, trims ends with cutters, and solders ends to terminals to connect components.

Ascertains from work order the type and quantity of back panels to be assembled. Obtains necessary number and type of panels from stock. Places panels in holding clamps mounted on revolving work wheel. Selects components such as fuse holders, cables, binding posts, etc., from supply trays on work bench. Fastens components to panel by means of screws, nuts and

Electronic Assembler (Cont.)

bolts, or solder, using such tools as Allen drivers, soldering iron, spin-tite wrench, etc. Assembles sectional panels in place according to specifications, using screws, nuts and bolts, and various hand tools such as screw drivers, wrenches and pliers.

Tests completed unit using electronic testing equipment and following work orders, test manuals, and schematic and wiring diagrams. Connects systems to be tested to such testing equipment as oscilloscopes, signal generators, frequency meters, spectrum analyzers, voltmeters, ohmeters, and milliammeters. Reads dials that indicate electrical characteristics of systems such as output, power, frequency, voltage, current distortion, inductance, and capacitance. Compares dial readings with specifications and records data or plots test results on graph. Calibrates systems to obtain specified dial reading of characteristics such as frequency or inductance. Traces circuits of defective systems, using knowledge of electronic theory and electronic test equipment to locate defects such as wiring errors, open wires, shorts, and faulty components. Examines switches, dials, and other hardware for conformance to specifications. Replaces defective wiring and components, using hand-tools and soldering iron, or records defects on tag attached to system and returns system to production department for repair.

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FACT SHEET

Job Title: Electronic Assembler (electronics) 726.781

Job Summary: Performs any one or a combination of production operations required to assemble a wide variety of electronic circuit boards and to wire electronic drawers, each containing several thousand wire connections. Uses small hand tools such as wire cutters, tweezers, soldering iron, strippers, crimpers, and extractors. Follows assembly diagrams and engineering specifications to insure that assembly and wiring procedures are properly performed. Makes constant visual and mechanical checks on production quality and work tolerances, using such devices as micrometers, scales, height gauges, and circuit testers. Prepares circuit board components such as diodes, resistors, capacitors, and transistors by clipping and bending leads. Installs hardware such as eyelets, component holders, clips, brackets, and soldering posts. Positions components on circuit boards. Attaches wires to terminals and solders circuit board connections. Wires electronic shelves by attaching connectors to shelf frame and inserting ends of wire into plug slots. Installs completed shelves, plugs, and other components in electronic drawer chassis and terminates free ends of interconnect, power and ground wires. Maintains production and inspection records according to appropriate production sequence.

Work Performed: Verifies information on production documents: Checks shop traveler, engineering change orders, shortage records, and operation sheets before beginning any phase of production work. Insures that information and instructions on these documents are complete and consistent.

Follows assembly specifications: Identifies components and types of wire to be used from listing on operation sheets while performing all production activities. Refers to assembly and wiring diagrams to insure that operations are performed according to engineering specifications. Maintains constant visual and mechanical checks to insure quality of production.

(This sheet is printed in duplicate. One copy should remain as part of the Appendix in order to complete the technical report. The other copy can be removed by employment service personnel who wish to set up separate fact sheet files.)

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